

March 1999 Groundwater Monitoring and Offsite Well Installation Report

Former International Light Metals Facility
19200 S. Western Avenue
Torrance, California



19 May 1999

P R E P A R E D F O R

Lockheed Martin Corp.
Burbank Program Office
2550 Hollywood Way, Suite 305
Burbank, California 91505-1055

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Prepared for:

**Lockheed Martin Corp.
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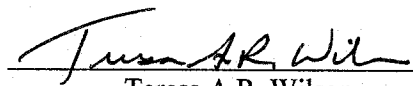
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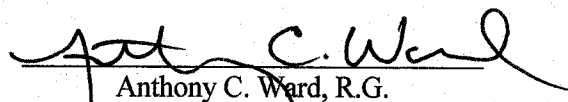
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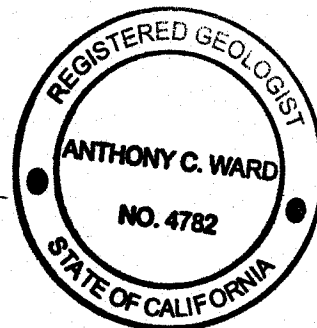
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May 19, 1999

Prepared by ARCADIS Geraghty & Miller, Inc.


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This report is executed in one or more counterparts, each of which shall be deemed an original, but all of which either together and separately, constitute one and the same document.

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1. Introduction

ARCADIS Geraghty & Miller, Inc. (ARCADIS Geraghty & Miller) was retained by Lockheed Martin Corporation (Lockheed Martin) to oversee offsite well installation and conduct groundwater monitoring for the former International Light Metals Division (ILM) facility located at 19200 South Western Avenue, Torrance, California. A site location map is provided as Figure 1. A map showing the surrounding area, including local industrial properties, is also included as Figure 2. This work is part of an ongoing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) being conducted specifically for groundwater beneath and downgradient from the former ILM facility. The RFI is being performed under the oversight of the California Department of Toxic Substances Control (DTSC), and according to a Consent Agreement between Lockheed Martin and the DTSC dated December 28, 1998. The groundwater RFI is designed to include collection of data to characterize offsite migration of constituents of concern to the extent that it is necessary to support the development of a health risk assessment and/or remedial action as may be required, as discussed in the Consent Agreement.

Work was conducted according to two workplans. Soil sampling, monitoring well installation, and groundwater sampling at the Boeing Realty Corporation (BRC) property (located directly east of and downgradient from the former ILM facility) was conducted according to the Offsite Groundwater Characterization Workplan prepared by Integrated Environmental Services, Inc. (IES, consultant to BRC) for Lockheed Martin and BRC dated December 1998 (IES 1998). Groundwater sampling at the former ILM facility was conducted according to the Groundwater RFI Workplan (Workplan) prepared by ARCADIS Geraghty & Miller for Lockheed Martin in 1996 (Geraghty & Miller 1996a), and specifically according to the Groundwater RFI Workplan dated March 15, 1999 with updated attachments to reflect current site conditions (Lockheed Martin 1999). Both workplans have been approved by the DTSC.

At the BRC property, eight wells were installed by Harding Lawson Associates (HLA) under direction of IES in February 1999. ARCADIS Geraghty & Miller gauged and sampled wells at the former ILM facility, and HLA, under oversight of IES, gauged and sampled the newly installed wells at the BRC property. Groundwater monitoring at both properties was conducted from March 1 through March 4, 1999. All field work at the former ILM facility was conducted in accordance with procedures described in the Groundwater RFI Workplan (Workplan) (Geraghty & Miller 1996a; Lockheed Martin 1999). Field work at both the former ILM and the BRC properties was

coordinated by Lockheed Martin and BRC to ensure consistency in data collection as described in the Consent Agreement.

1.1 Purpose and Organization

Groundwater well installation, gauging, and sampling were completed to provide updated information on groundwater conditions beneath and east of (downgradient from) the former ILM facility. The results of the groundwater gauging and sampling were compared with previous groundwater gauging and sampling results (Geraghty & Miller 1996b – e, Geraghty & Miller 1997) to identify variations in the nature of contamination in groundwater in this area. The new information obtained at the BRC property will be used to characterize the nature of groundwater contamination east of (downgradient from) the former ILM facility beneath the BRC property.

This report is organized as described below:

- Section 1: Introduction. This section describes the purpose and organization of the report, the site background, and a short description of the geology, hydrogeology, and groundwater flow at the former ILM facility and available information regarding the BRC property.
- Section 2: Methodology for Well Installation and Soil Sampling Results. This section provides descriptions of the methods used for well installation and soil sampling, sample handling and custody, soil cataloging, analytical methodology, and data evaluation.
- Section 3: Methodology for Groundwater Sampling and Results. This section provides short descriptions of the methods used for groundwater purging and sampling, sample handling and custody, analytical methodology, data evaluation, and waste water disposal. In addition, this section provides a description of the results of water-level measurements, field measurement of water quality parameters, and laboratory analyses of groundwater samples.
- Section 4: Quality Assurance/Quality Control (QA/QC) Evaluation. This section includes both a summary of data quality objectives and a summary of QA/QC results. The summary of QA/QC results includes a discussion of corrective measures taken and/or justification for use of data, where appropriate.
- Section 5: References. This section provides a listing of the bibliographic references included in the text.

Appendices for this report include the following:

- Appendix A: Boring/Well Construction Logs;
- Appendix B: Waste Disposal Documentation;
- Appendix C: Hydrographs;
- Appendix D: Groundwater Sampling Logs;
- Appendix E: Analytical Reports/Chain-of-Custody Forms/Data Validation Reports;
- Appendix F: Groundwater Data Tables; and
- Appendix G: Trichloroethene (TCE) Time/Concentration Graphs.

1.2 Site Background

The following sections provide a summary of the geology and hydrogeology of the subsurface at the former ILM facility and at the BRC property. More detailed information regarding the former ILM facility is provided in the Current Conditions Report (CCR) (ARCADIS Geraghty & Miller 1999) and the Draft Groundwater Data Assessment Report (Geraghty & Miller 1996b).

1.2.1 Geology and Hydrogeology

Based on the geology of the region and on information provided from site boring logs (Geraghty & Miller 1994, 1996b, and 1996f), the material found beneath the former ILM facility consists of unconsolidated sediments which were formerly capped in most places by steel-reinforced concrete or asphalt, and occasionally by discontinuous intervals of fill materials either at the surface or beneath the concrete/asphalt cap (Geraghty & Miller 1997). Currently the site is developed and capped with concrete and asphalt with the exception of approximately 15 acres in the northern portion of the property, which is currently planned for similar development (ARCADIS Geraghty & Miller 1999).

The sediments occur as a heterogeneous assemblage of silt, clay, and sand. These sediments, as well as the fill materials found at the former ILM facility, can be identified in six distinctive layers, described in detail in Section 4 of the Groundwater

RFI Workplan (Geraghty & Miller 1996a). The site-specific labels given these layers, in order of increasing depth, are fill material, Upper Clay/Silt, Upper Sand, Lower Clay/Silt, Lower Sand, and First Saturated Clay (FS Clay). These layers, together with sand to depths of approximately 98 to 108 feet (ft) below ground surface (bgs), likely correspond with the upper and middle portions of the Bellflower Aquiclude. The FS Clay, occurring discontinuously beneath the site, is found at depths ranging from 69 to 83 ft bgs. Although the FS Clay is itself unsaturated, it has been named "First Saturated" because it occurs within the first saturated interval encountered beneath the former ILM facility. Because the FS Clay is unsaturated, the groundwater overlying it is considered to be semiperched. Groundwater overlying the FS Clay is laterally and hydraulically continuous with groundwater where the FS Clay is absent; however, where the FS Clay is present, the top of the FS Clay correlates well with increases in groundwater elevation which occur above this unit.

Sand, occasionally interspersed with sandy clay lenses 1 to 4 ft thick, occurs below the FS Clay when it is encountered. Below the sand, an interval of silt and clay from 10 to 21 ft thick occurs at a depth of approximately 98 to 119 ft bgs; this is believed to correspond with the lower portion of the Bellflower Aquiclude. Because of its apparent continuity both on-site and off-site, this portion of the Bellflower Aquiclude may occur as a continuous hydraulic barrier beneath the site.

Underlying the Bellflower Aquiclude, the Gage Aquifer has been fully penetrated on-site by two borings (DB-1 and DB-2). The sands of the Gage Aquifer are interpreted to extend to 220 ft bgs in DB-1, and to 218 ft bgs in DB-2. Groundwater in the Gage Aquifer was encountered during drilling at approximately 145 ft bgs in both borings. Toward the base of the Gage Aquifer, a fossil/shell fragment interval was encountered in both borings. This occurred at 189 to 201 ft bgs and 211 to 220 ft bgs in DB-1, and at 200 to 210 ft bgs in DB-2 (Geraghty & Miller 1996b).

Identification of the Gage Aquifer was based upon 1) identified depths and thickness of the Bellflower Aquiclude and Gage Aquifer as indicated in regional studies (State of California Department of Water Resources [DWR] 1961); 2) lithologic characteristics of the unit, including the occurrence of marine fossils near the base of the unit, which is considered to be indicative of the base of the Gage Aquifer (Gonzales 1995); and 3) correlation with drillers' logs from other wells in the local area (Geraghty & Miller 1996b).

The formally unnamed aquitard below the Gage Aquifer, locally referred to as the El Segundo Aquitard, was partially penetrated by borings DB-1 and DB-2 (Geraghty & Miller 1996b). Other regional studies have indicated that it is approximately 110 ft

thick in this area (DWR 1961). Identification of this unit as the El Segundo Aquitard was based upon the depths and thickness of the Bellflower Aquitard, Gage Aquifer, and underlying aquitard provided in other regional studies (DWR 1961); and upon lithologic characteristics, including the presence of marine fossils at the base of the overlying Gage Aquifer. Also, in borings DB-1 and DB-2 the lithology between the fossil interval and the top of the aquitard is similar: a 2-ft interval of sandy, silty clay occurs at 211 ft bgs in DB-1 and at 210 ft bgs in DB-2, followed by an interval of very fine- to fine-grained sand 9 and 6 ft thick, respectively.

Groundwater beneath the BRC property occurs at approximately 65 feet bgs at the western property boundary, with flow generally to the southeast, bending to the south (IES 1998).

1.2.2 Groundwater Occurrence and Flow

The first occurrence of groundwater underlying the former ILM facility is generally found at depths ranging from approximately 65 to 70 ft bgs (Geraghty & Miller 1996f). The second occurrence of groundwater is located at approximately 82 ft bgs (Geraghty & Miller 1996b). Both of these occur within the middle portion of the Bellflower Aquiclude.

A regional potentiometric map was constructed in 1993 using available data for the period of October and November 1991 from the McDonnell-Douglas, Montrose Chemical, and Mobil refinery sites (Geraghty & Miller 1993). The data suggest that the direction of regional shallow groundwater flow is generally toward the southeast. A local water table "high" has been identified beneath the Mobil Oil facility, located approximately 2,500 feet west of the former ILM facility (Harding Lawson Associates 1986; Figure 2). This area of mounding is situated west of the surface impoundments located at the refinery. Further details of regional and site groundwater flow can be found in Section 4 of the Groundwater RFI Workplan (Geraghty & Miller 1996a).

The groundwater flow pattern within the middle portion of the Bellflower Aquiclude is complex due to the presence of discontinuous clay/silt layers, in particular the FS Clay, which result in semiperched conditions. In most of the potentiometric maps constructed for the site, there appears to be a general flow direction to the southeast with more complex groundwater flow over the areas of the FS Clay (Geraghty & Miller 1996b). For some wells, groundwater elevations are relatively high or low compared to the surrounding gradient. These patterns are indicative of the complexity caused by the presence of the clay layers. Depth-to-water measurements were collected at the former ILM facility from August 1994 to September 1996 as part of

both vadose zone and groundwater RFI activities. Throughout the period of measurement, the groundwater flow pattern at the site remained generally constant, indicating that although it is complex, the pattern is relatively stable (Geraghty & Miller 1996b - f).

Groundwater flow on the BRC property appears to be influenced or controlled by a persistent trough or depression along the eastern BRC property boundary (K/J 1996a,b,c).

1.2.3 Surrounding Area Contamination

Groundwater contamination source areas near the former ILM facility have been previously identified. These sources have been identified from public record reviews and from previous ARCADIS Geraghty and Miller reports. Facility names identified are used to provide the location of data provided and are not listed to assign or reflect responsibility for known contamination. The regional groundwater gradient for this area reflects a general groundwater flow to the southeast (ARCADIS Geraghty & Miller 1999).

Surrounding source areas include known groundwater contamination of VOCs, SVOCs, metals, pesticides, PCBs, cyanide, and TPH. Dissolved contaminants that have been monitored as part of the Montrose and Del Amo groundwater RCRA Investigation (areas to the east and south of the site) include VOCs, SVOCs, metals, PCBs, and cyanide. Contaminant concentrations exceeding MCLs or other regulatory standards include chlorobenzene, benzene, TCE, PCE, and others (ARCADIS Geraghty & Miller 1999).

The Mobil refinery, located approximately ½ mile west of the site (Figure 2), conducted groundwater sampling in 1998 and analytical results indicate benzene, toluene, ethylbenzene, and xylenes (BTEX) and VOC contamination in groundwater (Mobil 1998).

Boeing, Trico Industries, Penske Truck Leasing, Allied Signal and the Gardena Valley Landfill have documented VOC groundwater contamination. The contaminants include TCE, PCE, 1,1-DCE, 1,1-DCA, benzene, toluene, 1,1,1-TCA, and vinyl chloride. Further information and local maps can be found in the Current Conditions Report for the former ILM facility (ARCADIS Geraghty & Miller 1999).

2. Monitoring Well Installation and Soil Sampling

As mentioned above, eight monitoring wells were installed at the BRC property as part of this investigation. The monitoring wells were considered temporary due to ongoing property transfer and development activities at the BRC property, and the resulting need for the wells to be removed following sampling activities.

2.1 Methodology

The following sections describe the methods used during drilling, soil sampling, and well installation.

2.1.1 Drilling and Soil Sampling

Temporary groundwater monitoring wells BL-1 through BL-8 were installed on February 2 through 16, 1999 by Gregg Drilling and Testing Inc. of Signal Hill, California under the supervision of HLA. All drilling activities were overseen by ARCADIS Geraghty & Miller, and all procedures were in accordance with the DTSC-approved Quality Assurance Project Plan (QAPP) prepared by ARCADIS Geraghty & Miller in January 1996 and updated in March 1999 (Lockheed Martin 1999). Work was conducted as specified in the Offsite Groundwater Characterization Workplan prepared by IES for Lockheed Martin and BRC dated December 1998 (IES 1998).

2.1.1.1 Permits and Utility Clearance

Well construction permits were obtained prior to the start of work from the County of Los Angeles Department of Health Services.

Underground Service Alert (USA) was notified before the start of drilling activities for each borehole. Final well locations were adjusted based on field observations and USA clearance.

2.1.1.2 Drilling

Groundwater monitoring wells were installed using a Mobile B-61 drill rig equipped with 8-inch-outside diameter, continuous-flight, hollow-stem augers. Soil samples were collected from each boring at a depth of 2.5 feet, 5 feet, and then at 10-foot intervals thereafter until groundwater was encountered. Soil samples were collected using a modified California split spoon sampler containing three 2-inch-diameter by 6-inch-long brass sample retainers and driven by a 140-pound hammer (approximate

weight) dropped approximately 30 inches. The sample retainers were removed from the sampler immediately upon retrieval, sealed with Teflon[®] film and plastic end caps, labeled, entered into chain-of-custody protocol, placed in an ice-chilled cooler, and picked up by a courier on the same day and delivered to BC Laboratories, Inc. (BC Labs) in Bakersfield, California. Borings were logged from soil cuttings and soil samples.

Soil was field-tested for volatile organic compounds (VOCs) using a photo-ionization detector (PID) with an 11.7 electron volt (eV) lamp, characterized according to the Unified Soil Classification System (USCS) as presented in ASTM Standard D 2488, and classified by color using a Munsell Color Chart. The number of blows (blow counts) required to advance the sampler 18 inches was also recorded on the field boring log for each 6-inch increment. Soils were logged independently by ARCADIS Geraghty & Miller, and the resulting boring logs are presented in Appendix A.

Drilling equipment was steam-cleaned before drilling each well. All sampling equipment was cleaned with a non-phosphate detergent, rinsed with tap water, and final-rinsed with deionized water. All equipment was handled in a manner intended to prevent cross-contamination.

2.1.1.3 Soil Analytical Methodology

Soil samples were analyzed for VOCs using Environmental Protection Agency (EPA) Method 8260 and total petroleum hydrocarbons fuel fingerprint (TPH-ff) using EPA Method 8015M if the PID reading exceeded 50 parts per million (ppm) of organic vapors. TPH analytes included in the TPH-ff analysis include stoddard/white spirits, JP4, JP5, JP6, JP8, kerosene/jet fuel, diesel, crude oil, waste oil, and motor oil. Soil samples were further analyzed for polychlorinated biphenyls (PCBs) if there were TPH-ff detects and the chromatograms dictated to do so. The (approximately) 5-foot and 15-foot soil samples from each borehole were analyzed for Title 22 metals using EPA Method 6010. In addition, 10 percent of the soil samples (for a total of two samples) containing the highest levels of total chromium were analyzed for hexavalent chromium using EPA Method 7196.

2.1.1.4 Soil Waste Disposal

Soil cuttings were stored in on-site storage bins and were disposed of by IES upon receipt of analytical results. Manifests for soil disposal are included in Appendix B.

2.1.2 Monitoring Well Installation

Well installation was performed in accordance with procedures outlined in Bulletin No. 74-81, *Water Well Standards: State of California*, and Supplement 74-90, *California Well Standards* (DWR 1981 and 1991) and the procedures outlined below. Well locations are shown on Figure 3. Work was conducted as specified in the Offsite Groundwater Characterization Workplan prepared by IES for Lockheed Martin and BRC dated December 1998 (IES 1998). Wells were designated "temporary" due to the intention to remove some or all of the wells following data collection (IES 1998). Wells were, however, constructed as permanent wells with the exception of surface completion.

All eight groundwater monitoring wells were constructed with 20 feet of 2-inch-diameter, Schedule 40, 0.01-inch slot, polyvinyl chloride (PVC) screen and PVC blank casing to the surface. RMC Lonestar No. 2/12 sand was used as backfill to approximately 3 to 4 feet above the screen interval. Wells were surged and additional sand was added as needed. An approximately 3- to 5-foot-thick seal of bentonite chips was added to each well. Water was added during the placement of the bentonite, and the seal was allowed to hydrate. The remaining annulus was grouted with a bentonite slurry. Wells were left uncompleted at the surface (as temporary wells). As of the date of this report, these temporary wells have not been removed nor converted to permanent wells. Should one or more of these wells become permanent, the wells will be completed at the surface with flush-mount traffic-rated well boxes according to the workplan (IES 1998). Well completion details are presented in Appendix A.

2.1.2.1 Well Development.

The wells were developed approximately 48 hours after the wells were installed using a mobile auger research limited development rig. Groundwater levels were measured and well volumes were calculated for all wells. The wells were bailed using a decontaminated stainless steel bailer and swabbed using a 2-inch swab to remove heavy sediments. Once most of the sediments were out of the well, a submersible pump was used for the remainder of the development. Development continued until field parameters (pH, conductivity, temperature, turbidity, and dissolved oxygen) had stabilized and at least five well volumes had been removed. Field parameters were considered stable when measurements were within 10 percent for three consecutive readings.

2.1.2.2 Water Waste Disposal

Decontamination water and development water were stored on site in a 500-gallon aboveground storage tank and was disposed of by IES upon receipt of analytical results. Manifests for water disposal are included in Appendix B.

2.2 Discussion of Monitoring Well Installation and Soil Sampling Results

Geological, soil analytical, and well installation results are discussed in this section. Locations of soil samples are referenced by the corresponding well identification (e.g., BL-5).

2.2.1 Geological Results

The lithology encountered during drilling at BL-1 through BL-8 was primarily silt, silty sand, and fine-grained sand. The borings were completed to depths of approximately 78 to 82 ft bgs, typically in fine-grained sand. No clay layers were encountered in these borings. Fill material was recorded in each boring to a maximum depth of 9.5 ft bgs. Groundwater was encountered at depths ranging from 66.6 to 71.5 ft bgs. Boring logs are included in Appendix A.

This lithological information is somewhat consistent with the lithology found beneath the former ILM facility, with the exception that clay and silt layers were frequently encountered above 80 ft bgs beneath the former ILM property. The FS Clay, upon which groundwater is perched in some areas beneath the former ILM facility, has typically been found at depths of 69 to 83 ft bgs, as discussed in Section 1.2.1.

2.2.2 Soil Analytical Results

A total of 19 soil samples was submitted for analysis according to the criteria specified in Section 2.1.1.3. Eighteen of these were analyzed for metals, one sample was analyzed for VOCs and TPH, and two samples were analyzed for hexavalent chromium. The results of these analyses are summarized in the sections below.

2.2.2.1 VOCs

A soil sample from 8 feet bgs at BL-5 was analyzed for VOCs using EPA Method 8260. VOCs were not detected in this sample at or above laboratory practical quantitation limits (PQLs).

2.2.2.2 TPH

A soil sample from 8 feet bgs at BL-5 was analyzed for TPH-ff using EPA Method 8015M. TPH was not detected in this sample at or above PQLs.

2.2.2.3 Metals

At the BRC property, a total of 18 soil samples from all eight well locations were analyzed for metals by EPA Method 6010. Samples were collected from various depths in these borings. Table 1 identifies the sample depths and their analytical results.

Sixteen metals analytes were detected above their PQLs in these soil samples. Eleven of these metals were found in all 18 soil samples analyzed. These include arsenic, aluminum, barium, chromium, cobalt, beryllium, nickel, titanium, zinc, vanadium, and copper.

Aluminum, chromium, and hexavalent chromium are metals which have historically been of interest at the former ILM facility. In the BRC soil samples, aluminum was detected at concentrations ranging from 13,500 (BL-8 at 22 feet bgs) to 27,400 (BL-7 at 14.5 feet bgs) milligrams per kilogram (mg/kg). Chromium was detected at concentrations ranging from 17 (BL-8 at 22 feet bgs) to 32 (BL-1 at 11.5 feet bgs) mg/kg. Hexavalent chromium was detected in the 2 samples analyzed at concentrations of 0.4 (BL-1 at 11.5 feet bgs) and 1.2 (BL-5 at 10 feet bgs) mg/kg.

The aluminum concentrations are below the EPA Region 9 Residential Preliminary Remediation Goal (PRG) for aluminum of 75,000 mg/kg. Chromium and hexavalent chromium concentrations are also below Residential PRGs, which are 210 and 30 mg/kg, respectively.

2.2.3 Well Installation Results

The groundwater monitoring wells were installed as described in Section 2.1.2. The wells were developed 48 hours following installation as described in Section 2.1.2. Well construction logs are included in Appendix A.

3. Groundwater Sampling

Depth to water was measured and groundwater samples were collected from existing groundwater monitoring wells at the former ILM facility, and from newly installed

temporary monitoring wells at BRC, in March 1999. Work was conducted according to the Groundwater RFI Workplan (Geraghty & Miller 1996a) and the Workplan for March 1999 Groundwater Monitoring (Geraghty & Miller 1999b). Work at the former ILM facility was conducted according to the site-specific health and safety plan, updated in March 1999 (Geraghty & Miller 1999b, Attachment).

3.1 Methodology

The following sections describe the methods used during groundwater gauging and sampling. Note that at the former ILM facility, 13 wells have been abandoned since the July 1997 monitoring event. These include P-4, P-6, P-8, P-9, P-11, P-13, P-14, P-15, P-18, P-19, P-21, P-23, and P-25. Wells P-6 and P-9 were replaced within approximately 10 and 50 feet by P-6B and P-9B, respectively. These wells were abandoned based on development plans at the property. Well P-16B has also been abandoned due to damage caused during site demolition activities. Abandonment dates are included on Table 3.

3.1.1 General Sampling Methods

The investigation methodology utilized during groundwater gauging and sampling is in accordance with standard industry practice. Standard Operating Procedures (SOPs) for methods used in the investigation are included in Attachment B of the groundwater RFI QAPP, which is Appendix D of the Groundwater RFI Workplan (Geraghty & Miller 1996a). Groundwater sampling methods are also discussed in Section 6 of the Groundwater RFI Workplan.

3.1.1.1 Gauging

Depth-to-water measurements were collected at 15 wells at the former ILM property and eight wells at the BRC property according to procedures set forth in Section 6.2 of the Groundwater RFI Workplan (Geraghty & Miller 1996a).

Depth to water and total well depth measurements were performed and recorded using a Solinst electronic water interface probe. At Well P-5, where free product has historically been present on the groundwater surface, an Oil Recovery System (ORS) interface probe was used. Measurements were collected relative to a standard measuring point, which for each well is the north side of the top of the well casing. This measuring point has been surveyed relative to mean sea level, allowing calculation of groundwater elevation from the depth measurements.

3.1.1.2 *Purging and Sampling*

Prior to sampling, and following collection of a complete set of depth-to-water measurements as described above, each well to be sampled was purged of a minimum of 4 well-casing volumes. Wells which are slotted in a low permeability zone, however, were purged dry once. Purging procedures were conducted as described in Section 4.8.1 of the QAPP and according to SOP #9 in Attachment B of the QAPP (Geraghty & Miller 1996a [Appendix D]). These procedures include collection of field data from each well, including pH, temperature, conductivity, and turbidity.

Groundwater samples were collected from each well (with the exception of P-5, where free product was detected in the well during gauging) after the wells were allowed to recover to at least 80 percent of the original water column. The collection of groundwater samples was conducted as described in Sections 4.8, 4.9, 4.10, and 5.0 of the QAPP, and in SOP #10 in Attachment B of the QAPP (Geraghty & Miller 1996a [Appendix D]).

3.1.1.3 *Sample Handling*

To preserve sample integrity, all samples submitted for laboratory analysis were tracked according to standard chain-of-custody protocols and were handled according to standard industry practices. Sample handling and custody methods are discussed in detail in Sections 4.11, 4.13, and 5.0 of the QAPP (Geraghty & Miller 1996a [Appendix D]).

3.1.1.4 *Analytical Methodology*

Chemical analyses of samples collected during groundwater monitoring were conducted by BC Labs according to protocols discussed in the Groundwater RFI Workplan (Geraghty & Miller 1996a) and the Workplan for March 1999 Groundwater Monitoring (Geraghty & Miller 1999b). Groundwater samples were analyzed for the chemical analytes listed below. The results of these analyses are discussed in Section 3.2 of this report. The analyses were conducted according to the methodology discussed in Section 7.2 of the QAPP (Geraghty & Miller 1996a [Appendix D], updated in ARCADIS Geraghty & Miller 1999b). Analyses of groundwater samples were conducted according to the appropriate workplan using the following methods:

- Total petroleum hydrocarbons fuel fingerprint (TPH-ff) by United States Environmental Protection Agency (EPA) Method 8015M (as modified in the California Department of Health Services LUFT Manual); analytes include

stoddard/white spirits, JP4, JP5, JP6, JP8, kerosene/jet fuel, diesel, crude oil, waste oil, and motor oil.

- Volatile organic compounds (VOCs) by EPA Method 8260;
- Total metals by USEPA Methods 6010 (aluminum, antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, molybdenum, nickel, silver, titanium, vanadium, and zinc), 7421 (lead), 7470 (mercury), 7841 (thallium), 3114 (arsenic and selenium), and 7196 (hexavalent chromium); and
- Dissolved metals by USEPA Method 6010 (aluminum, antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, molybdenum, nickel, silver, titanium, vanadium, and zinc), 7421 (lead), 7470 (mercury), 7841 (thallium), 3114 (arsenic and selenium), and 7196 (hexavalent chromium).

Table 2 provides a summary of which analyses were applied to specific samples. All groundwater samples collected from the former ILM facility were analyzed for the above parameters. Groundwater samples from the BRC property were analyzed as above with the exception of TPH, for which two groundwater samples were analyzed, per the BRC workplan (IES 1998). No sample was collected from Well P-5 due to the presence of free product, and therefore no analyses were performed.

3.1.1.5 Quality Control Sampling

To verify laboratory results, one duplicate sample was collected from the former ILM facility (at P-20), and one from the BRC property (at BL-1). One equipment rinsate sample was collected for each day in the field at each property to verify decontamination procedures; laboratory-grade, organic-free water was poured on a decontaminated sampler and into certified-clean sample bottles. One trip blank, supplied by the laboratory, accompanied each sample cooler containing samples for VOC analyses.

Quality control samples were documented according to chain-of-custody protocol, placed in an ice-chilled cooler, and picked up by a courier on the same day and delivered to BC Labs in Bakersfield, California. Equipment rinsate samples and trip blanks were analyzed for VOCs using EPA Method 8260.

3.1.1.6 Waste Disposal

Waste water generated from groundwater well purging and sampling activities was temporarily stored on-site in Department of Transportation (DOT)-approved 55-gallon drums pending off-site disposal. Disposal of the waste water was handled by Belshire Environmental Services, Inc., located in Lake Forest, California. The waste water, classified as RCRA Hazardous (D040), was removed from the site for transport to U.S. Filter Recovery Services, Inc., a waste disposal facility located in Los Angeles, California. The hazardous waste manifest is included in Appendix B of this report.

3.1.2 Off-Site Monitoring Well Methodology

All eight of the newly installed temporary groundwater monitoring wells at the BRC property were gauged and sampled according to the methodology described in Section 3.1.1. These wells were gauged and sampled March 1 through 4, 1999.

3.1.3 Former ILM Facility Methodology

All 15 of the existing wells at the former ILM property were gauged according to the methodology described in Section 3.1.1. Fourteen of those wells were sampled according to the methodology described in Section 3.1.1. Well P-5 was not sampled due to the presence of free product. These wells were gauged on March 1, 1999, and sampled on March 2 through 4, 1999.

3.2 Discussion of Groundwater Monitoring Results

Groundwater gauging, purging, and analysis results are discussed in the sections below. These results are summarized in Tables 3 through 14. Tables 3, 5, 7, 9, 11, and 13 include results from activities conducted at the former ILM facility; Tables 4, 6, 8, 10, 12, and 14 include results from activities conducted at the BRC property.

3.2.1 Groundwater Elevations

Groundwater elevations at the former ILM facility ranged from -8.24 to -13.90 feet relative to mean sea level (ft msl) (Table 3). Groundwater elevations at the BRC property ranged from -12.46 to -14.56 ft msl (Table 4). The overall direction of groundwater flow is towards the south-southeast across both properties, with a few local areas of groundwater mounding at P-2 and P-20. A map showing contours of equal groundwater elevation is provided as Figure 4.

Between July 1997 and March 1999, an overall increase in groundwater surface elevation occurred beneath the former ILM facility (Table 3; Figure 4). Changes in groundwater elevation ranged between +0.15 ft (P-10) and +1.62 ft (P-7). Overall, the general direction of groundwater flow remained the same, toward the south-southeast with two areas of mounding (Figure 4). The groundwater gradient, as calculated between Wells P-2 and P-7, was approximately 0.003 foot of vertical displacement per horizontal foot (ft/ft). There was no change in groundwater gradient from the July 1997 sampling event, which was also calculated to be 0.003 ft/ft between Wells P-2 and P-7.

3.2.2 Field Results

Between March 2 and 4, 1999, 14 groundwater wells at the former ILM facility were purged prior to groundwater sampling. At least four well casing volumes were purged from 12 wells; the remaining two wells (Wells P-2 and P-24) were purged dry because the recharge rate was too low to maintain water in the wells during purging. During purging activities, measurements for temperature, pH, electrical conductivity, and turbidity were collected, and the color of the purge water was recorded for approximately each well volume purged. These parameters were measured as described in Section 4.8.1 of the QAPP (Geraghty & Miller 1996a [Appendix D]). Water sampling logs, which include records of the field measurements, are presented in Appendix D. The field measurements, including historical measurements, are tabulated in Table 5.

For March 1999, the final groundwater temperature in the 14 wells was between 21.8 degrees Centigrade (°C) (Wells P-9B and P-10) and 23.1 °C (Wells P-6B and P-22). The final pH reading for groundwater ranged between 6.72 (Well P-20) and 7.46 (Well P-6B). The final conductivity reading ranged between 1,850 micromhos per centimeter (µmhos/cm) (Well P-24) and 5,220 µmhos/cm (Well P-2). Final turbidity readings were between 0 and 10 Nephelometric Turbidity Units (NTUs) in eight wells. Turbidity exceeded 10 NTUs in the remaining six wells.

At the BRC property, all eight wells were purged of three casing volumes of groundwater prior to sampling. During purging activities, measurements for temperature, pH, electrical conductivity, turbidity, and dissolved oxygen were collected, and the color of the purge water was recorded for approximately each well volume purged. Water sampling logs, which include records of the field measurements, are presented in Appendix D. The field measurements are tabulated in Table 6.

The BRC wells exhibited similar temperature and pH field results to the former ILM facility wells, and slightly different overall conductivity and turbidity results. The final temperature ranged from 22.3°C (Well BL-5) to 24.3°C (Well BL-6). The final pH reading for groundwater ranged between 6.36 (Well BL-1) and 7.33 (Well BL-4). The final conductivity reading ranged between 577 µmhos/cm (Well BL-4) and 3,680 µmhos/cm (Well BL-3). Final turbidity readings were between 10 and 100 NTUs in four wells. Turbidity exceeded 100 NTUs in the remaining four wells.

3.2.3 Groundwater Chemical Analyses

After purging, the groundwater wells were allowed to recharge to at least 80 percent of the original water column before sampling. Fifteen groundwater samples were collected from the former ILM facility, including one duplicate sample from Well P-20. Nine groundwater samples were collected from the BRC property, including one duplicate sample from Well BL-1. Figure 3 shows the well locations.

A sample was not collected from Well P-5 because a layer of free product approximately 0.01 inch thick was detected in the well during water-level measurement activities. Although the sample from Well P-16C was analyzed for the same compounds as the other wells and data for this well were included in the tables of groundwater results, the analytical results were not included on figures depicting the distribution of concentrations. This is because Well P-16C, by design, was slotted at a deeper interval than the other wells, at the base of the Bellflower water-bearing zone.

Results of laboratory analyses of the groundwater samples are discussed in the following sections. Summary results of groundwater analyses, which exclude analytes not detected in any of the samples, are found in Tables 7 through 14. Appendix D contains sampling logs for each groundwater sample collected. Analytical reports, chain-of-custody forms, and data validation reports are located in Appendix E. Groundwater data tables, which present detailed analytical results for the March 1999 sampling event, are included in Appendix F.

3.2.3.1 VOCs

At the former ILM facility, 12 VOC compounds were detected above their practical quantitation limits (PQLs) in the 14 wells sampled in March 1999. TCE was the most frequently detected VOC compound, detected in all 15 samples. The main constituent of total VOCs, by frequency of detection and by concentration, was TCE, which ranged in concentration between 0.70 micrograms per liter (µg/L) (Well P-2) and 8,100 µg/L (P-1). TCE was the only VOC analyte detected in two of the wells. When

compared with results from the July 1997 sampling event, TCE concentrations decreased in 11 wells. Graphs showing historical trends in TCE concentrations are included in Appendix G. There was an overall increase in PCE, 1,1-DCA, 1,1-DCE, and 1,1,1-TCA. The distributions of TCE, PCE, 1,1-DCE, and 1,1-DCA in groundwater beneath the former ILM facility are illustrated in Figures 5 through 8, respectively. The current and historical VOC concentrations are summarized in Table 7.

At the BRC property, VOC compounds were detected above their PQLs in the eight wells sampled in March 1999. TCE was the most frequently detected VOC compound, detected in all nine samples. As at the former ILM facility, the main constituent of total VOCs, by frequency of detection and by concentration, was TCE. TCE ranged in concentration between 4.1 µg/L (Well BL-5) and 720 µg/L (BL-3), with the exception of 6,700 µg/L detected at BL-6. The distributions of TCE, PCE, 1,1-DCE, and 1,1-DCA in groundwater beneath the BRC property are illustrated in Figures 5 through 8, respectively. The VOC results are summarized in Table 8.

Configurations of groundwater plumes for these analytes generally correspond with the direction of groundwater flow (Figure 4) with respect to known source areas, with the exception of TCE. The concentration of TCE at BL-6 appears to be cross-gradient from historical elevated TCE concentrations in groundwater at P-20.

Other VOC analytes detected in groundwater include 1,1,1-TCA, 1,1,2-TCA, 1,2-DCA, 1,2-DCE (cis- and trans-), 1,2-dichloropropane, chloroform, benzene, and toluene. The analytes 1,1,1-TCA, 1,1,2-TCA, and 1,2-DCA were often detected in wells where these analytes have not previously been detected; however, historical detection limits were higher than for the most recent analysis. The detection of cis-1,2-DCE and trans-1,2-DCE in March 1999 could be a result of reductive dechlorination occurring in the groundwater beneath the site. Chloroform, a common laboratory contaminant, was detected at a maximum concentration of 31 µg/L. A concentration of 1,2-dichloropropane was detected in one well (P-12) at 2.9 µg/L. Benzene was detected in four wells (P-1, P-7, P-12, and P-20) at a maximum concentration of 6.7 µg/L; toluene was detected in four offsite wells (BL-4, BL-6, BL-7, and BL-8) at a maximum concentration of 8.4 µg/L.

3.2.3.2 TPH

At the former ILM facility, samples from 14 wells were analyzed for TPH-ff. TPH was detected in eight wells during March 1999. TPH as diesel (TPH-d) was detected in Wells P-7, P-16A, and P-24 at concentrations ranging from 210 µg/L to 450 µg/L.

TPH as kerosene (TPH-k) was detected in Well P-2 at a concentration of 2,300 µg/L. TPH as crude/waste oil was detected in Wells P-6B and P-10 at 1,100 µg/L and 1,500 µg/L, respectively. TPH-d was also detected previously in groundwater samples from Well P-5, but groundwater from that well was not sampled in March 1999 because free product was encountered there during water-level measurement activities. A summary of groundwater analytical results for TPH at the former ILM facility is located in Table 9. The distribution of TPH-d in groundwater beneath the former ILM facility is illustrated in Figure 9. The number of wells with concentrations of TPH has increased since the 1997 sampling event. The presence of TPH (crude oil) at P-10 may be attributed to offsite sources such as the Mobil refinery located west of the former ILM facility (Figure 2). TPH-k has decreased in Well P-2 from 20,000 µg/L in July 1997 to 2,300 µg/L in March 1999.

At the BRC property, two monitoring wells were tested for TPH. TPH-d was detected in concentrations ranging from 450 µg/L to 610 µg/L. A summary of TPH analytical results is included in Table 10. TPH-k, TPH as crude/waste oil, and TPH as z-oil (a water-soluble hydraulic oil used during former operations at the ILM facility) was not detected in any of the samples from the BRC wells. The wells for which TPH was analyzed and detected are in the northern portion of the BRC property, near Well P-5 at the former ILM property. Well P-5 has historically revealed concentrations of TPH-d and the presence of free product.

3.2.3.3 Metals

Groundwater samples were analyzed for dissolved and total metals during the March 1999 sampling event, as described in Table 2. These metals included but were not limited to aluminum, cadmium, lead, hexavalent chromium, mercury, and thallium. A summary of groundwater analytical results for dissolved metals, including hexavalent chromium, is included in Tables 11 and 12 for the former ILM facility and the BRC property, respectively. A summary of results for total metals is included in Tables 13 and 14 for the former ILM facility and the BRC property, respectively. The distributions of total aluminum, dissolved aluminum, and dissolved hexavalent chromium are shown on Figures 10, 11, and 12, respectively.

At the former ILM facility, total aluminum was detected in samples from 14 wells tested for aluminum. Dissolved aluminum was not detected in any of the samples analyzed. This pattern of aluminum detection continues a trend which was noted in the July 1997 and previous sampling events, which is most likely due to both the turbidity of samples and the natural background concentrations of aluminum in clays (Geraghty & Miller 1996e). Total lead was detected in nine groundwater samples (including one

duplicate); dissolved lead was not detected in any of the samples. Dissolved hexavalent chromium was detected in 13 groundwater samples (including one duplicate).

At the BRC property, total aluminum was detected in all nine groundwater samples tested for aluminum (including one duplicate). Dissolved aluminum was not detected in any of the samples. Total lead was detected in all nine samples (including one duplicate), and dissolved lead was not detected in any of the samples. Dissolved hexavalent chromium was detected in all nine samples (including one duplicate).

Distribution patterns of aluminum in groundwater may be closely related to background concentrations of metals in the soil, as mentioned above. However, hexavalent chromium, detected in 13 groundwater samples at ILM with concentrations ranging between 2.5 and 1,280 $\mu\text{g/L}$, was not detected in concentrations exceeding its PQL in any soil samples collected during the supplemental soil RFI activities (ARCADIS Geraghty & Miller 1997). Hexavalent chromium was detected in nine groundwater samples (including one duplicate) at the BRC property with concentrations ranging between 4.1 to 167 $\mu\text{g/L}$. Two soil samples at BRC were analyzed for hexavalent chromium as part of this field program; both contained concentrations of hexavalent chromium, at a maximum of 1.2 mg/kg.

4. QA/QC Evaluation

Data Quality Objectives (DQOs) for March 1999 groundwater monitoring are established so that high quality, legally defensible data will be collected. QA/QC procedures are described in the QAPP (Geraghty & Miller 1996a [Appendix D] and Lockheed Martin 1999). These procedures include field and laboratory QC as well as performance and systems audits.

4.1 Objectives of DQOs

DQOs are defined so that precision, accuracy, representativeness, comparability, completeness, and sensitivity of analytical methods and associated data can be quantified and evaluated using standardized terminology for any project. Precision, accuracy, and completeness are technical DQOs that can be evaluated by using specific mathematical formulas. Representativeness, comparability, and sensitivity are DQOs that address the appropriateness of workplans, investigation strategies, and laboratory methods. The final assessment and documentation of DQOs, and whether or not they

are met, are end products of a field investigation, and are typically addressed in the data validation and data evaluation process.

4.2 Summary of the Data Validation Evaluation

Data validation qualifiers were applied to 32 of approximately 2,498 (1%) analytical results from 24 groundwater samples, including two duplicate samples, during the data validation process. The qualifiers are described in detail in the Data Validation Summaries, found at the end of Appendix E. All of the flagged results were determined to be estimated and detected ("J"), estimated and not detected ("UJ"), or not detected ("U"). No results were deemed to be unusable.

Data validation qualifiers were applied to 31 of approximately 403 (8%) analytical results from 19 soil samples, during the data validation process. The qualifiers are described in detail in the Data Validation Summaries, found at the end of Appendix E. All of the flagged results were determined to be estimated and detected ("J"), estimated and not detected ("UJ"), or not detected ("U"). No results were deemed to be unusable.

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